

Effects of Alternate Leading Edge Cutback on the Space Shuttle Main Engine Low Pressure Fuel Pump

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A higher order cavitation oscillation observed in the SSME low pressure fuel pump has been eliminated in water flow testing of a modified subscale replica of the inducer. The low pressure pump was modified by removing the outboard sections of two opposing blades of the four-bladed inducer, blending the “cutback” regions into the blades at the leading edge and tip, and removing material on the suction sides to decrease the exposed leading edge thickness. The leading edge tips of the cutback blades were moved approximately 25 degrees from their previous locations, thereby increasing one blade to blade spacing, decreasing the second, while simultaneously moving the cutback tips downstream. The test was conducted in MSFC’s inducer test loop at scaled operating conditions in degassed and filtered water. In addition to eliminating HOC across the entire scaled operating regime, rotating cavitation was suppressed while the range of both alternate blade and asymmetric cavitation were increased. These latter phenomena, and more significantly, the shifts between these cavitation modes also resulted in significant changes to the head coefficient at low cavitation numbers. Reverse flow was detected at a slightly larger flow coefficient with the cutback inducer and suction capability was reduced by approximately 1 velocity head at and above approximately 90% of the reference flow coefficient. These performance changes along with more intense reverse flow are consistent with poor flow area management and increased incidence in the cutback region. Although the test demonstrated that the inducer modification was successful at eliminating the higher order cavitation across the entire scaled operating regime, different, previously unobserved, cavitation oscillations were introduced and significant performance penalties were imposed.